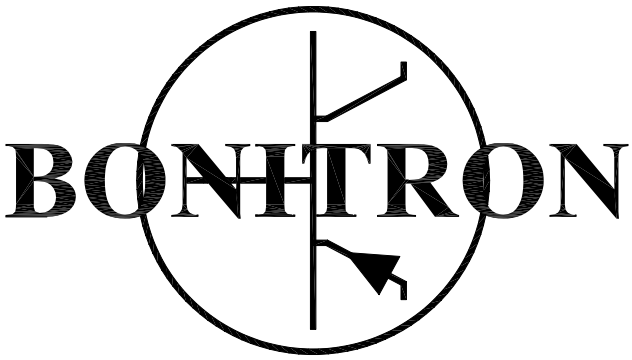


Bonitron Power Source
Model M3534EC-E2.2-xxx-E61
400VAC, 2.2kW, 0.2 – 0.8kJ
Full Outage DC Bus Ride-Thru System for Variable Speed AC Drives

Customer Reference Manual

TEL. (615) 244-2825 • FAX (615) 244-2833 • www.bonitron.com

Bonitron, Inc.

An Industry Leader in AC Drive Systems and Industrial Electronics

OUR COMPANY

Bonitron Inc. is an industrial electronics and electrical systems design, engineering, and manufacturing company founded in 1962 and located in Nashville, Tennessee. Bonitron designs and manufactures custom and standard product modules and systems for industry with the highest possible degree of quality and reliability.

Bonitron has all the necessary resources in-house for complete electronic product development and manufacturing. Engineering facilities include a CAD lab for circuit board design and engineering labs for prototype testing and evaluation. Production facilities include production areas for circuit board assembly, a machine tool and sheet metal shop for chassis fabrication, and a systems assembly and checkout area. With these assets, Bonitron is positioned to be a leader into the future while maintaining first class support for their current customer base.

Sales of equipment, generated mainly by reputation and referrals, are worldwide. The customer base includes ABB, Allen-Bradley, Control Techniques, GE, Magnetek, Reliance, Siemens, and other fine companies. Equipment is installed in most of the fifty states, Canada, Mexico, Brazil, Argentina, Northern Ireland, Holland, Spain, India, Hungary, Turkey, Indonesia, and China.

TALENTED PEOPLE MAKING GREAT PRODUCTS

The engineering team at Bonitron has the background and expertise needed to design, develop, and manufacture the quality industrial systems demanded by today's client. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. Expertise encompasses a broad range of applications and engineering solutions such as modern power conversion design techniques and microprocessor-based controls. This insures a solution tailored to the specific needs of the client.

A clear advantage that Bonitron has over many competitors is combined on-site engineering labs and manufacturing facilities. This allows the engineering team to have immediate access to and response from testing and manufacturing. This not only saves time during prototype development, but also is essential to providing only the best quality products.

AC DRIVE OPTIONS

In 1975, Bonitron began working with the AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced to their plant process computers. Since that time, Bonitron has developed AC drive option modules that help overcome many of the problems encountered in applications of modern AC adjustable speed drives. Bonitron's Ride-Thru module provides protection from AC line voltage sags while the Line Regen and Resistive Braking modules provide DC Bus regulation for over-voltage due to regenerated voltage. Today, many drive system integrators use Bonitron AC drive option modules with their adjustable speed drives.

WORLD CLASS PRODUCTS

Bonitron has developed over 3000 different modules and systems. Bonitron is willing and able to meet the unique specifications the client may request.

Some Bonitron products include:

- Power Sag Ride-Thru Modules
- Power Outage Ride-Thru Modules
- Line Regen Modules
- Resistive Braking Modules
- Modular High Speed Precision AC Inverter Systems
- Inverter Upgrade Modules
- Multi-motor, Multi-phase Current Sensors
- Battery Production Charging Systems
- Data Acquisition Systems
- Process Controllers
- Temperature Control Systems
- RMS True Reading Digital Voltmeters, Ammeters, and Frequency Meters

1. INTRODUCTION

1.1. WHO SHOULD USE

This manual is intended for use by anyone who is responsible for integrating, installing, maintaining, troubleshooting, or using this equipment with any AC Drive System.

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the BPS Model M3534EC Full Outage DC Bus Ride-Thru system. It will provide the user with the necessary information to successfully install, integrate, and use the M3534EC Module in a variable speed AC drive system.

In the event of any conflict between this document and any publication and/or documentation related to the AC drive system, the latter shall have precedence.

1.3. MANUAL VERSION AND CHANGE RECORD

This is the initial printing (Rev 00) of the D3534EC_CMAN_vGENall manual.

Figure 1-1: M3534EC-E61

2. PRODUCT DESCRIPTION / FEATURES

Bonitron Power Source (BPS) Model M3534EC Full Outage DC Bus Ride-Thru Module provides protection from AC line voltage sags and outages for AC drive systems that use a fixed DC bus as with AC PWM Adjustable Speed Drives (ASDs). Including the M3534EC as part of a fixed bus inverter system will enable the system to surpass SEMI-47 compliancy specifications.

ASDs are commonly used in industry to improve control over continuous process applications, such as in the textile and semiconductor industries, where very accurate motor speed control is required. Unfortunately, these systems are quite susceptible to problems caused by fluctuations of incoming power, such as AC line voltage sags or outages. Long downtimes as well as large and costly production losses have been experienced due to ASD shutdowns caused by these occurrences.

The majority of AC line voltage fluctuations that occur in three-phase distribution systems have a magnitude (decrease from nominal voltage) of less than 50% and duration of less than 2 seconds. However, 100% power outages can still occur, and even one such instance can be costly. For this reason, the M3534EC incorporates additional energy reservoirs known as Bus Support Modules (BSMs) which allows the BPS to supply DC bus power to the inverter during total outages of a predetermined duration in addition to its normal sag protection. This can provide sufficient time for auxiliary power systems to engage before shutdown occurs. Or, it may allow the drive system to ride through the outage completely thus avoiding the problems associated with other power supply backup methods.

2.1. RELATED PRODUCTS

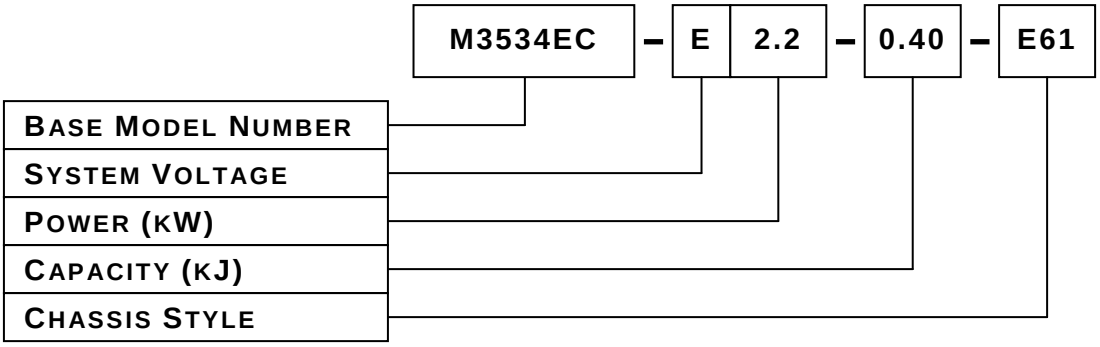
M3534CR

M3534UR

M3460UR

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The Base Model Number for these 100% sag AC Input DC Bus Ride-Thru Modules is **M3534EC.**

SYSTEM VOLTAGE RATING

The System Voltage rating indicates the nominal AC / DC voltage levels of the AC drive system the BPS is intended to support.

BPS Model M3534EC is available for either of several standard AC / DC voltages.

A code letter indicates the system voltage.

Table 2-1: System Voltage Rating Codes

RATING CODE	VOLTAGES (NOMINAL AC LINE / DC BUS TRIGGER LEVEL)
U	115VAC Line / 190VDC
L	230VAC Line / 375VDC
E	400VAC Line / 620VDC
H	460VAC Line / 750VDC
C	575VAC Line / 940VDC

POWER (KW)

The Power rating indicates the maximum power in kilowatts that can safely be handled by the M3534EC control unit. This rating is directly represented by a 3-digit value. For instance, the rating for a 2.2kW BPS is **2.2**.

CAPACITY(KJ)

The Capacity Rating indicates the maximum usable stored energy that the M3534EC will have available to support the DC bus at the minimum bus voltage setpoint for the specified system voltage. The capacity is directly represented in kilojoules by a 3-digit value. Fractional values are indicated as two-place decimals. For example, a 0.4 kilojoules maximum capacity is indicated as **0.40**. (*see Section 7*)

CHASSIS STYLE

Enclosure type and size is dependent on the Ride-Thru system specifications.

Table 2-2: Chassis Styles and Codes

CHASSIS CODE	CHASSIS DESCRIPTION
E61	24”(H) x 20”(W) x 12”(D) Type-12 wall mount enclosure

2.3. GENERAL SPECIFICATIONS

Table 2-3: General Specifications

PARAMETER	SPECIFICATION
Bus Support Modules	ASM-3534EC-E050 or ASM-3534EC-E100
Storage Capacitance	See the Charts in Section 7
Usable Storage Capacity	See the Charts in Section 7
AC Input Voltage	380 – 415VAC
DC Output Voltage	535 – 585VDC (455 minimum)
Power Rating	.25 Amps DC continuous
Maximum Outage Duration	Divide Capacity (kJ) by Motor Power (in kW) See “Capacity” in Figure 2-1 or Usable kJ Charts in Section 6
Precharge Time	Approximately 8 seconds
Precharge Current	Approximately 5A peak per cap assy
Discharge Times	< 60 seconds from 540VDC to 50VDC through discharge resistor ≈ 90 minutes from 540VDC to 50VDC without discharge resistor
Discharge Resistance	780 Ohms
Inactive Power Usage	Less than 2 watts per cap assembly
Field Connections	AC line input DC bus output Ground
Disconnect	6-pole for AC in / DC out with aux. contact & door mounted actuator
Metering	Storage Reservoir Voltmeter mounted on enclosure door
Operating Temperature	40° C
Humidity	Below 90% non-condensing
Atmosphere	Free of corrosive gas and dust

2.4. General Precautions and Safety Warnings

DANGER!

- High voltages may be present!
- Never attempt to operate this product with the enclosure cover removed!
- Never attempt to service this product without first disconnecting power to and from the unit!
- Always allow ample time for residual voltages to drain before opening the enclosure door.
- **FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH!**

CAUTION!

- Certain components within this product may generate high ambient temperatures during operation.
- Always allow ample time for the unit to cool before attempting service on this product.
- Before attempting installation or removal of this product, be sure to review all drive and/or resistive load documentation for pertinent safety precautions.
- Installation and/or removal of this product should only be accomplished by a qualified electrician in accordance with National Electrical Code or equivalent regulations.

ANY QUESTIONS AS TO APPLICATION, INSTALLATION, OR SERVICE SAFETY SHOULD BE DIRECTED TO THE EQUIPMENT SUPPLIER.

3. INSTALLATION INSTRUCTIONS

WARNING!

Installation and/or removal of this product should only be performed by a qualified electrician in accordance with National Electrical Code or local codes and regulations.

Proper installation of the BPS Model M3534EC Ride-Thru Module should be accomplished following the steps outlined below. Be sure to refer to the AC Drive instruction manual as these steps are performed. Please direct all installation inquiries that may arise during the installation and start up of this product to the equipment supplier or system integrator.

3.1. ENVIRONMENT

The installation site for the module should be chosen with several considerations in mind.

- The unit has a NEMA-12 rating and will therefore require some protection from the elements.
- Conduit access for field wiring is provided on the top-right surface of the enclosure.
- The unit will require a minimum clearance of two (2) inches in all directions around it when mounted near a non-heat source.
- The mounting surface should be clean and dry.

3.2. UNPACKING

Upon receipt of this product, please verify that the product received matches the product that was ordered and that there is no obvious physical damage to the unit. If the wrong product was received or the product is damaged in any way, please contact the supplier from which the product was purchased.

3.3. MOUNTING

Once the installation site has been selected as outlined above, the unit should be mounted in place. The RTM enclosure is provided with (4) 7/16" diameter mounting holes.

Mounting holes should be drilled and mounting studs or anchors installed before positioning the enclosure. Mounting hardware is not supplied.

Refer to the Dimensions section of this manual to determine the correct mounting dimensions and provisions for the unit.

CAUTION!

THE RTM ENCLOSURE IS HEAVY!

A minimum of two people should be used to position the unit!

3.4. WIRING AND CUSTOMER CONNECTIONS

This section provides information pertaining to the field wiring connections of the M3534EC Ride-Thru Module. Actual connection points and terminal numbers of the AC Drive system will be found in the documentation provided with that system.

Be sure to review all pertinent AC Drive System documentation as well as the "RTM To Drive Interconnection" details listed below before proceeding.

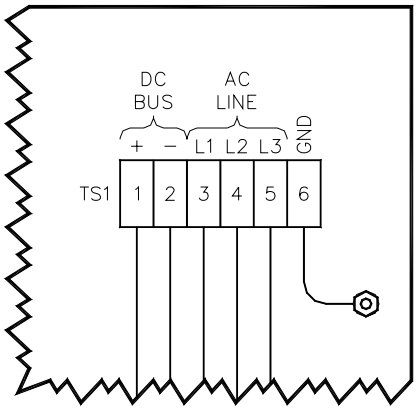
WARNING!

Interconnect wiring of this product should only be done by a qualified electrician in accordance with National Electrical Code or equivalent regulations.

Table 3-1: Field Wiring Connections

TERMINAL	ELECTRICAL SPECIFICATIONS	MAX WIRE AWG	TORQUE RANGE	
			LB-IN	N M
1, 2 (DC bus) 3, 4, 5 (AC line)	600VAC / 27Amps	12	3.5 – 5.3	0.4 - 0.6
6 (ground)		12	5.3	0.6

Figure 3-1: M3534EC Field Connection Terminal Layout



3.4.1. POWER WIRING

Two illustrations are provided to assist with the field connection of the M3534EC Ride-Thru module to an existing AC drive system. Also, be sure to refer to the documentation supplied with the drive system for field connection points within that system.

Figure 3-1 shows terminal number and connection names.

Figure 3-3 shows typical power interconnection of the M3534EC Ride-Thru Module with an existing AC Drive System.

Field connection terminals for the DC Bus output, AC Line input, and Ground are located on field connection terminal strip TS1 at the top right of the RTM enclosure backplate. All field interconnections to the drive system should be made using 14 AWG to 10 AWG wire.

DC BUS OUTPUT (TS1-1,2)

Make the DC bus output interconnections to terminals TS1-1 (DC Pos.) and TS1-2 (DC Neg.). Connections should be made using 14 AWG to 10 AWG wire. Torque all terminal screws to 5 lb.-in.

3-PHASE AC LINE INPUT (TS1-3,4,5)

The 3-phase AC Line input interconnections are made at terminals TS1-3, TS1-4, and TS1-5 on field connection terminal strip TS1.

Connections should be made using 14 AWG to 10 AWG wire. Torque all terminal screws to 5 lb.-in.

GROUND (TS1-6)

Make the Ground interconnection to terminal TS1-6. Connection should be made using 14 AWG to 10 AWG wire. Torque terminal screw to 5 lb.-in.

3.4.1.1. SOURCE CONSIDERATIONS

Source should be able to supply discharge current of 4 amps peak per cap module.

3.4.1.2. GROUNDING REQUIREMENTS

Cabinet should be earth grounded at TS1-6 for safety.

3.5. TYPICAL CONFIGURATIONS

Figure 3-2: Typical Field Connect Terminal Layout (TS1)

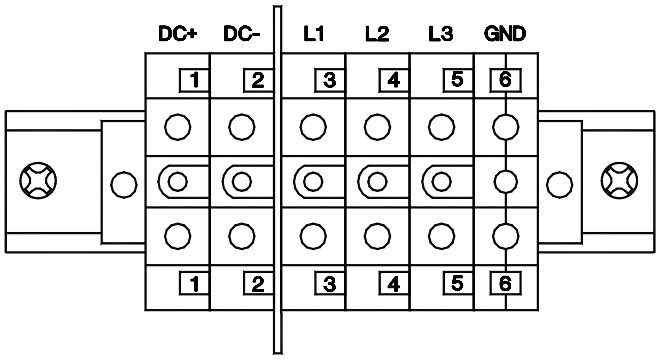


Figure 3-3: Typical M3534EC Interconnection With Existing Drive System

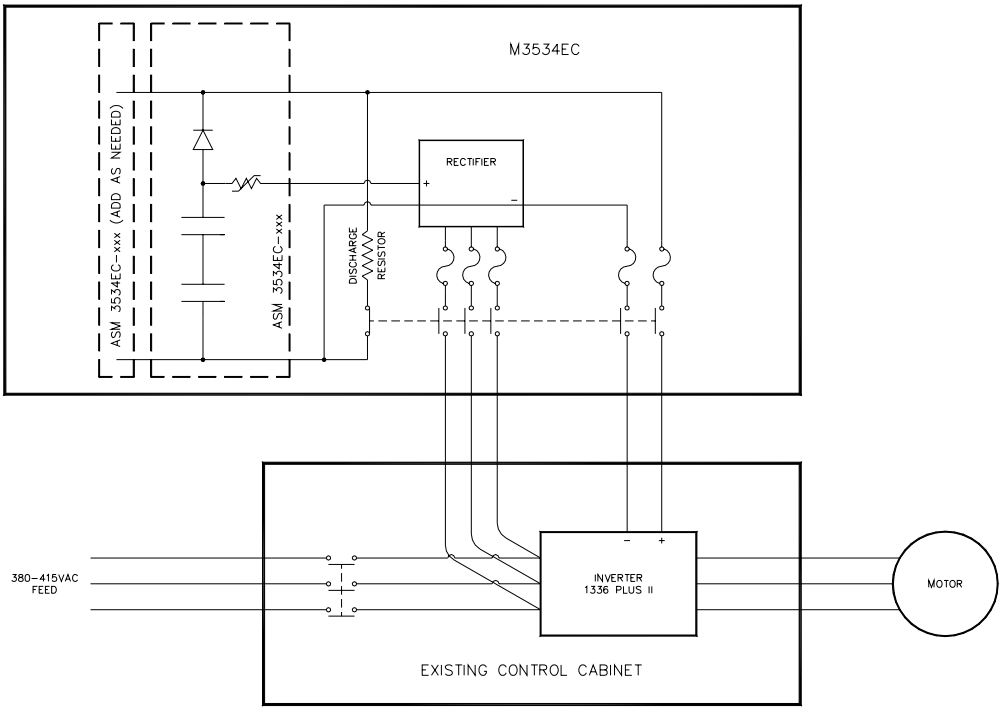
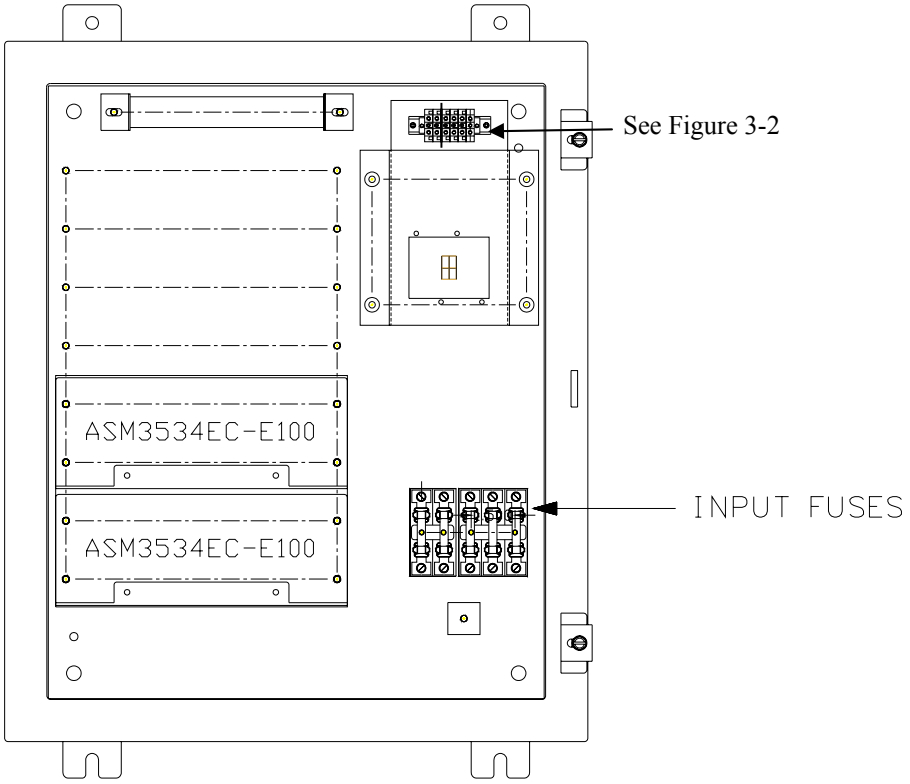


Figure 3-4: M3534EC 0.4kJ E61 Ride-Thru System with 2 Cap Banks Internal Layout



4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The BPS M3534EC is a passive energy storage reservoir designed to maintain the DC bus of electronic equipment during power sag or loss conditions. During a voltage sag or outage, the inverter DC bus level will be supported by the energy stored within the M3534EC's internal bus support modules.

Upon application of power to the M3534EC Capacitive Energy Reservoir, its internal Bus Support Modules (BSMs) will begin to precharge. BSMs used in the BPS system incorporate their own slow precharge controls. Complete precharge of the BSM reservoir to nominal DC bus level takes approximately 8 seconds. A door-mounted voltmeter indicates the total BSM reservoir voltage. Once the DC bus has fully precharged to its preset nominal value (approximately 565VDC for 400VAC systems), the Ride-Thru system is ready to protect from full outages for the duration specified for the system.

The BPS Model M3534EC employs a modular design that allows reservoirs of various capacities to be assembled by connecting fixed Bus Support Modules (BSMs) in parallel configurations. Each Bus Support Module includes its own precharge circuitry, which is designed to open in the event that a capacitor fails within the BSM. By opening, the Precharge circuit limits the energy to the failed capacitor and prevents itself from burning out. In addition, this selective shutdown of a failed capacitor allows the remaining Capacitive Energy Reservoir system to continue functioning at a reduced capacity.

4.2. FEATURES

4.2.1. TERMINAL STRIP I/O

There are no control or status signals for external connection on standard M3534EC modules.

4.2.2. LOCAL INDICATORS

There are no local indicators on M3534EC modules.

4.2.3. LOCAL METERS (BUS VOLTAGE)

A 1mA input DC voltmeter displays the storage capacitor bank voltage. Each set of capacitors adds some current to the meter via high value resistors. If one set of caps drops in voltage, the meter will drop accordingly. Each meter is trimmed to read accurately using shunt resistance at time of production.

4.3. STARTUP

4.3.1. PRE-POWER CHECKS

1. Ensure Power connections have proper torque.
2. Ensure DC bus connections between drive and BPS are the proper polarity.

4.3.2. STARTUP PROCEDURE AND CHECKS

The associated drive should be powered up and proven operational before adding the BPS unit on line

1. With power already applied to the associated drive, turn on disconnect switch.
   a. Cap voltage meter should read cap bank as it charges
   b. Pre-charge of cap bank should last approximately 8 seconds.
   c. Cap bank DC voltage should read 1.4 times the AC line RMS voltage

M3534EC is now ready for operation. Full power operational testing is recommended during commissioning. Often this is not possible because the complete system is not online, or motor is not fully loaded, and once on line, the pressure to get production going usually outweighs any desire to test. For testing methods see Section 5.1.

4.4. OPERATIONAL ADJUSTMENTS

There are no operational adjustments to BPS M3534EC modules.

4.5. CALIBRATION

Front panel voltmeter is trimmed at factory to be within 2% and should not require calibration. If the voltmeter reads low, voltage across each cap bank should be checked.

5. MAINTENANCE AND TROUBLESHOOTING

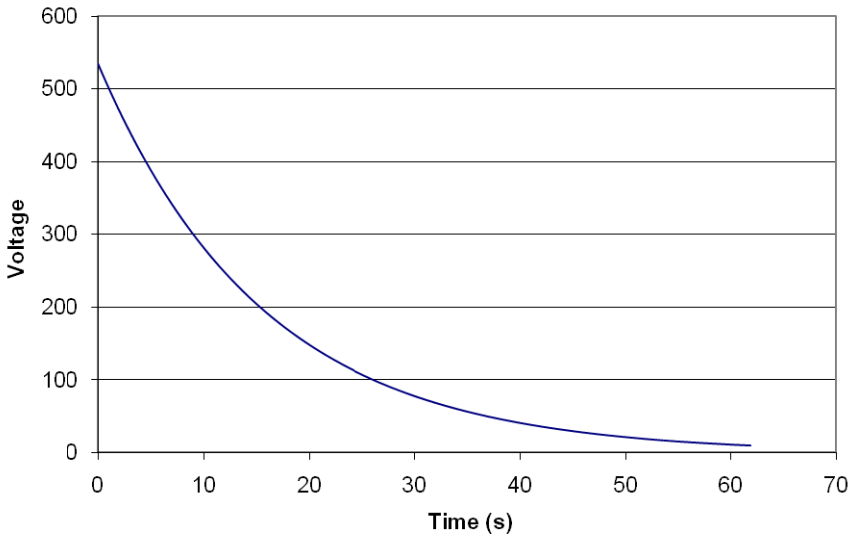
Repairs or modifications to this equipment are to be performed by Bonitron approved personnel only. Any repair or modification to this equipment by personnel not approved by Bonitron will void any warranty remaining on this unit.

5.1. PERIODIC TESTING

Yearly testing of BPS Ride-Thru capability is recommended for critical applications. Testing can be done by removing power to the drive system, or by verifying the BPS capacity through calculation.

1. Remove power to the drive system for the specified outage time.
   - Monitor motor speed or watch system parameters.
2. Turn off the disconnect to the BPS unit.
   - Monitor cap bank voltage with oscilloscope and compare to discharge waveform in Figure 5-1.
     - Each BPS M3534EC is equipped with an internal discharge resistor that is used to drain the capacitor bank for maintenance purposes. The resistance and discharge curve can be used to calculate the capacitance, which can then be used to figure usable kJ. See Section 7.5.

Figure 5-1: Discharge Curve Using Internal 780 Ohm Resistor



5.2. MAINTENANCE ITEMS

5.2.1. CAPACITOR REPLACEMENT CRITERIA

Bonitron Model 3534EC Ride-Thru uses high quality aluminum electrolytic capacitors and is designed for long life without maintenance. While a typical inverter may require capacitor replacement after a certain time due to the heavy ripple currents, the M3534EC typically is in a standby mode waiting for a power disturbance, and there is no ripple current, thus no heating.

The capacitor manufacturer has given a rating of 11 years MTBF if ambient temp is 50°C, capacitors are held at 100% rated voltage, and caps run full ripple current at 1% duty.

With typical operating conditions of 35°C, caps running at 75% rated voltage, and a duty cycle of one sag per month, Bonitron recommends the capacitors be checked every 5 years or replaced every 20 years.

The recommended test is to measure the voltage across each series set of capacitors. Any voltage difference greater than 15% between each set of series caps would indicate a change in value in one cap, or an extreme increase of leakage, and would constitute a more detailed out of circuit capacitance check. (a difference of 5% is allowed at time of production)

CAPACITOR TESTING PROCEDURE:

1. Remove Lexan covers to gain access to capacitor terminals.
2. Measure voltage across each cap and make note for future reference.
   - Any voltage difference more than 15% indicates a substantial change in capacitance or leakage.
     Example: DC bus = 540V, each series cap = 270V.
     15% of 270 = 40.5V cap 1 = 290V cap 2 = 250V.
3. If any set of caps is out of tolerance, remove power and replace both capacitors.

5.3. TROUBLESHOOTING

SYMPTOM	ACTION
No Ride-Thru capability	• Check for voltage reading on cap bank • If OK check DC output fuses • If OK, do capacity test.
No voltage on meter	• Check for 380VAC at input to box • If OK Check AC line fuses
Low voltage on meter	• Check each individual cap pack, measuring on cap terminals o Each cap pack supplies some voltage to meter. If one out of two cap packs is at zero volts, the meter will read half voltage o Bonitron's design will allow a cap pack to fail short and not affect the remaining cap packs, with the Cap Voltage meter reading proportionally low.

6. ENGINEERING DATA

6.1. RATINGS CHARTS

Table 6-1: Kjoule Ratings for 400VAC M3534EC 100% Ride-Thru Systems

kJ① Rating	BSM QTY	Total Capacitance (microfarads)	Usable Energy @ Nom. Line (kilojoules)	Usable Energy @ 5% Below Nom. Line (kilojoules)	Usable Energy @ 7% Below Nom. Line (kilojoules)	Usable Energy @ 10% Below Nom. Line (kilojoules)
0.20	1	10,000	0.40	0.26	0.20	0.13
0.40	2	20,000	0.80	0.52	0.40	0.25
0.60	3	30,000	1.19	0.78	0.61	0.38
0.80	4	40,000	1.59	1.03	0.81	0.50
1.00	5	50,000	1.99	1.29	1.01	0.63
1.20	6	60,000	2.39	1.55	1.21	0.75
1.40	7	70,000	2.79	1.81	1.41	0.88
1.60	8	80,000	3.19	2.07	1.61	1.00
1.80	9	90,000	3.58	2.33	1.82	1.13
2.00	10	100,000	3.98	2.58	2.02	1.26
2.20	11	110,000	4.38	2.84	2.22	1.38
2.40	12	120,000	4.78	3.10	2.42	1.51
2.60	13	130,000	5.18	3.36	2.62	1.63
2.80	14	140,000	5.58	3.62	2.82	1.76
3.00	15	150,000	5.97	3.88	3.03	1.88
3.20	16	160,000	6.37	4.13	3.23	2.01
3.40	17	170,000	6.77	4.39	3.43	2.14
3.60	18	180,000	7.17	4.65	3.63	2.26
3.80	19	190,000	7.57	4.91	3.83	2.39
4.00	20	200,000	7.97	5.17	4.03	2.51

① The **kJ** rating of the Model **M3534EC** 100% Ride-Thru module is based on the "**Usable**" energy of electrolytic storage reservoir assemblies as charged with a 7% low line voltage, and an inverter under-voltage trip point of 455VDC (85% of nominal 380VAC line). (See Figure 6-1) The actual usable energy of the reservoir will vary according to drive under-voltage trip point and line or bus voltage levels. Refer to Figures 6-2 thru 6-4 for "Usable Energy" curves representing 1-10 reservoir assemblies for each line voltage level.

Figure 6-1: Usable kJ @ -7% Line with Drive Undervoltage Trip Point of 455VDC

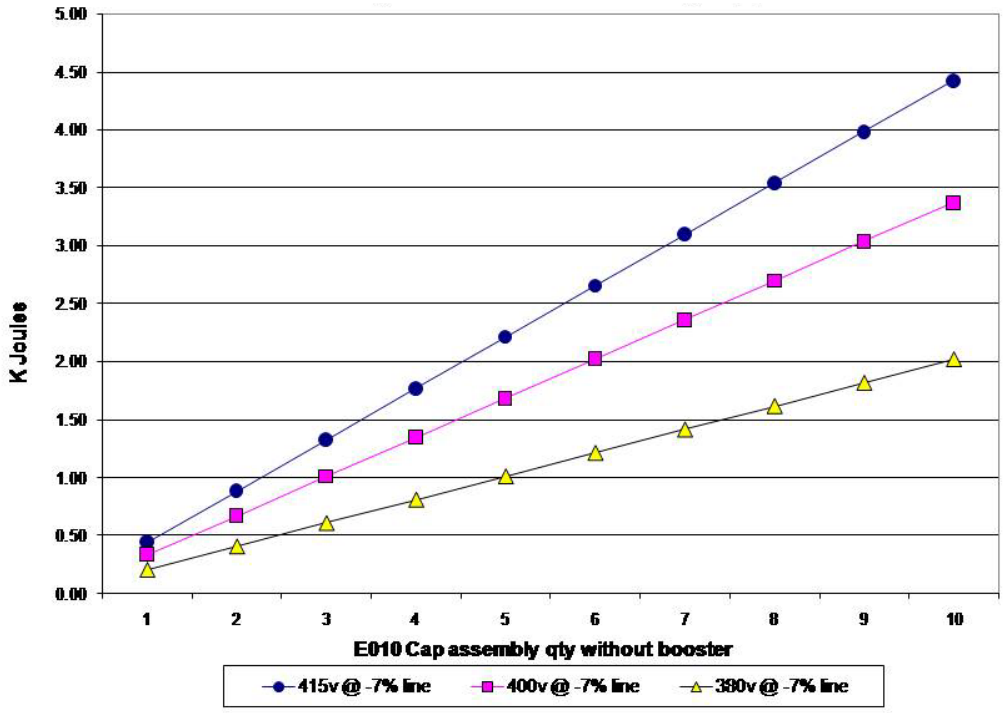


Figure 6-2: Usable kJ with 380V Feed, Drive Undervoltage Trip Point of 455VDC

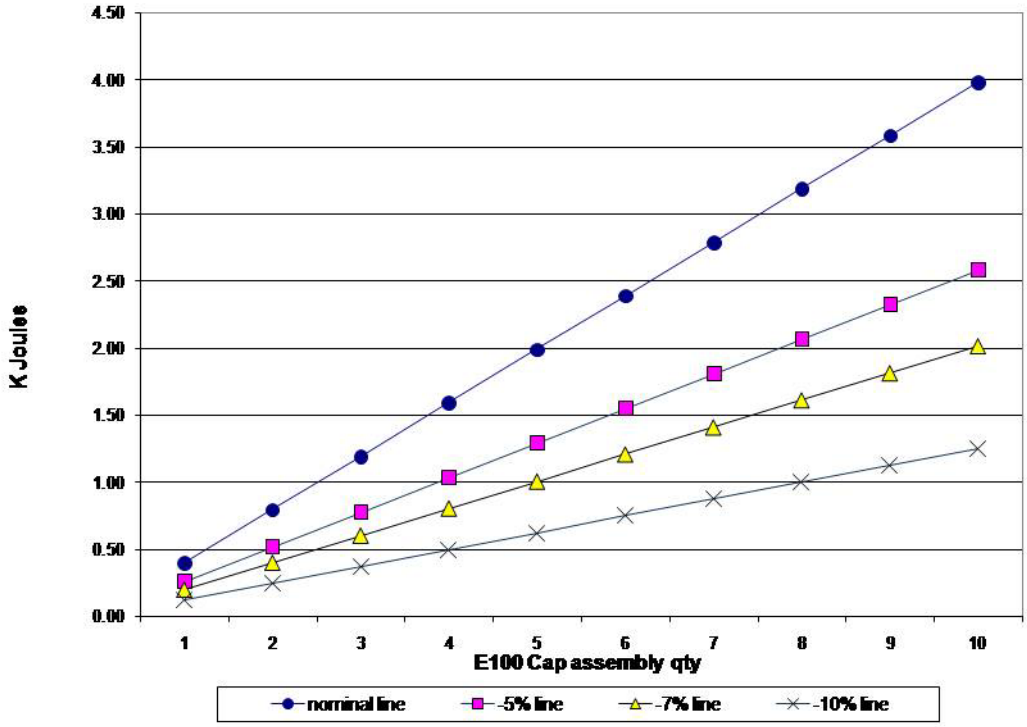


Figure 6-3: Usable kJ with 400V Feed, Drive Undervoltage Trip Point of 455VDC

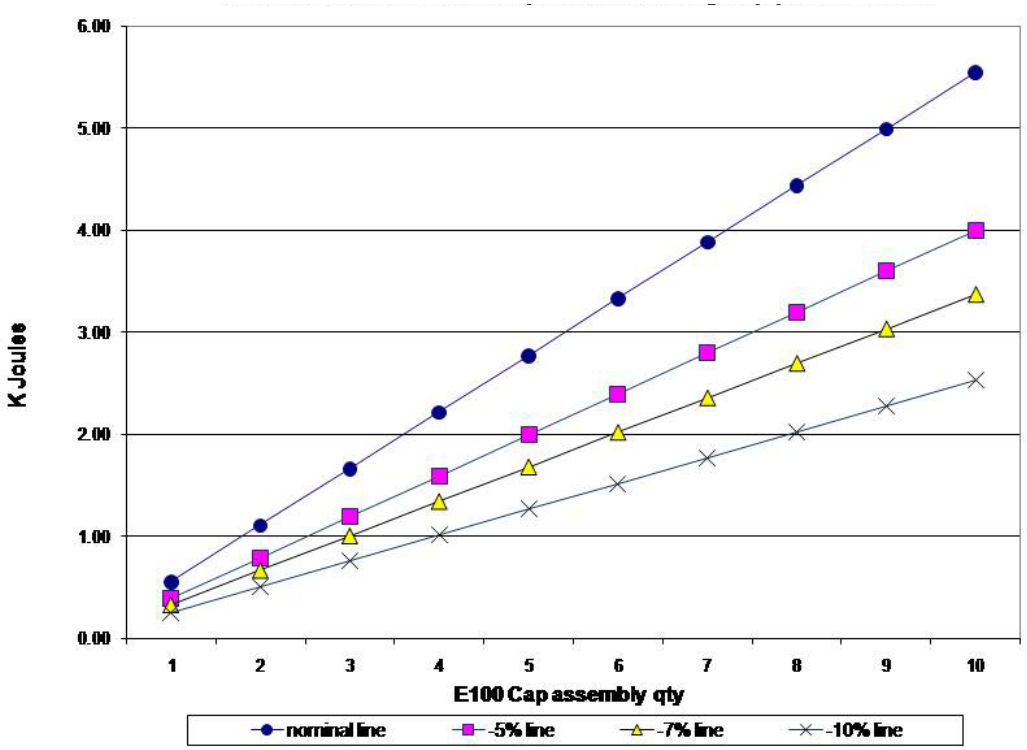
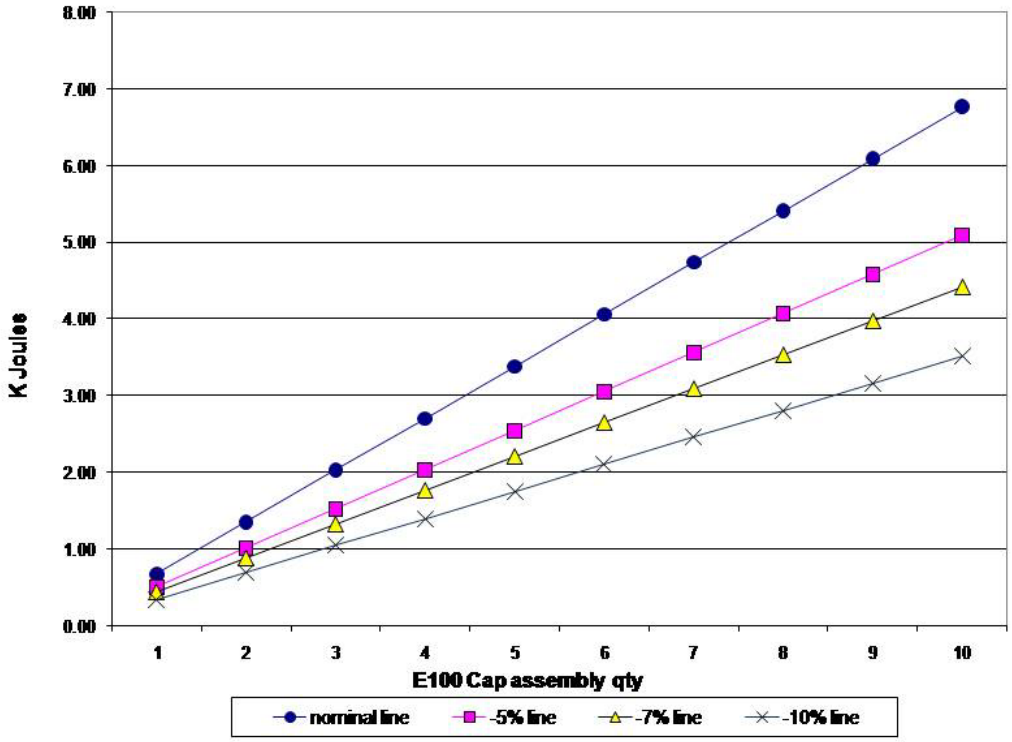


Figure 6-4: Usable kJ with 415V Feed, Drive Undervoltage Trip Point of 455VDC



6.2. WATT LOSS

Less than 2 watts per cap assembly.

6.3. CERTIFICATIONS

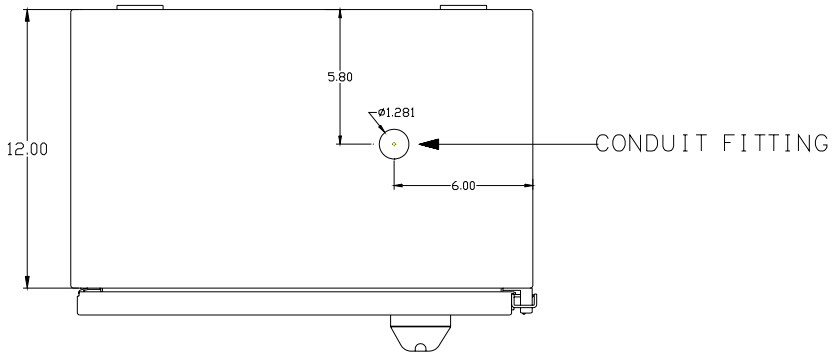
None

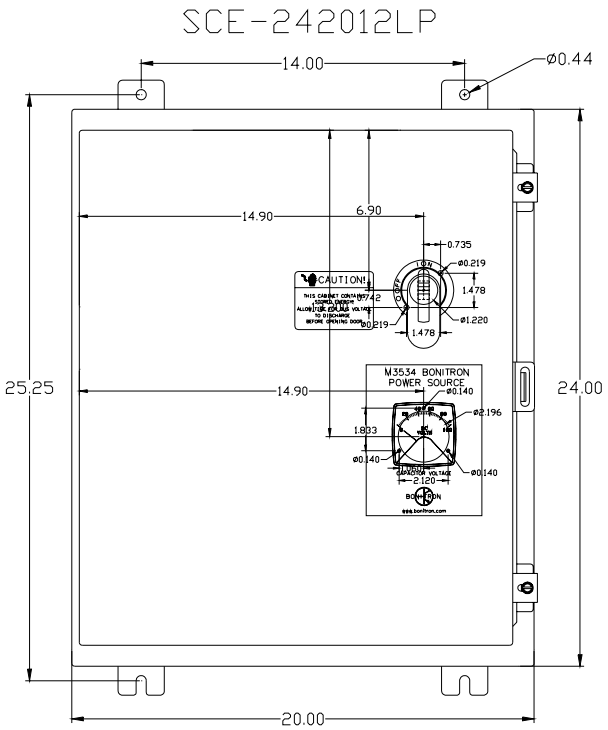
6.4. FUSE SIZING AND RATING

AC Line input: (3) ATM-10 – 1 fuse per phase
DC Bus output: (2) A60Q5-2 – 1 fuse per leg

6.5. DIMENSIONS AND MECHANICAL DRAWINGS

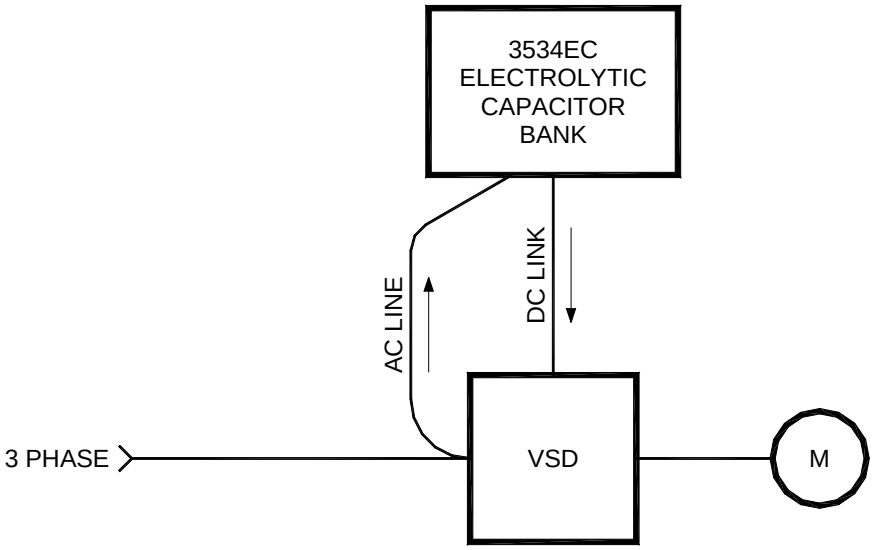
Figure 6-5: M3534EC Ride-Thru 'E61' 0.4kJ Enclosure Dimensional Outline





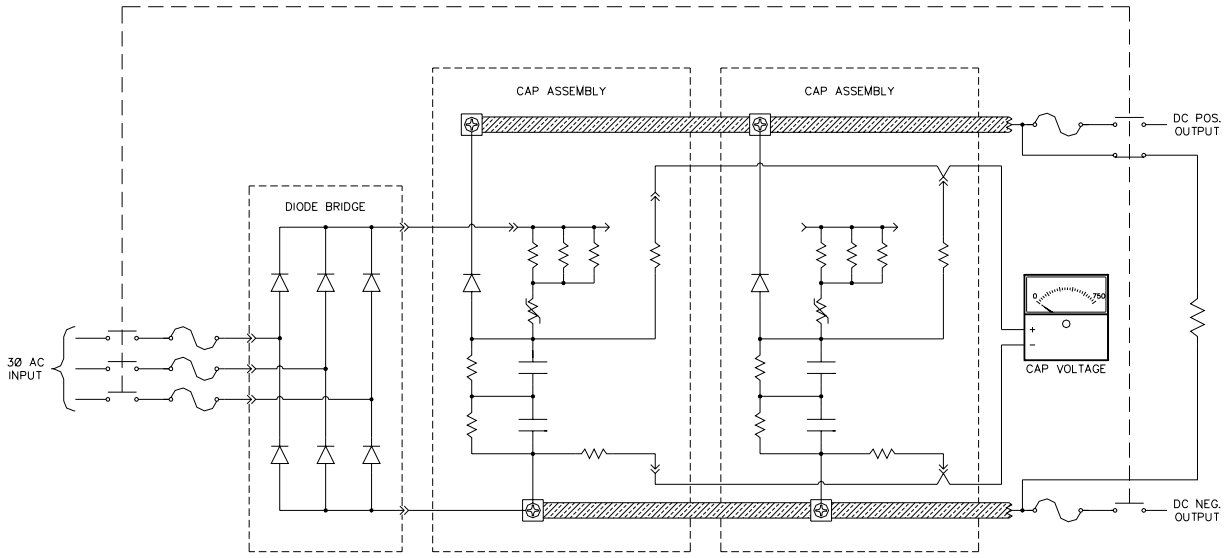
6.6. BLOCK DIAGRAMS

Figure 6-6: BPS Ride-Thru System Configuration 11



2.5KW & BELOW, 0 - 0.5 SECOND, 100% OUTAGE PROTECTION
USING ELECTROLYTIC CAP RESERVOIR
SINGLE CABINET POWERED FROM AC LINE

Figure 6-7: BPS M3534EC Basic Schematic



6.7. SUPPLEMENTAL DRAWINGS

Figure 6-8: Inverter - Bonitron Power Source Connections

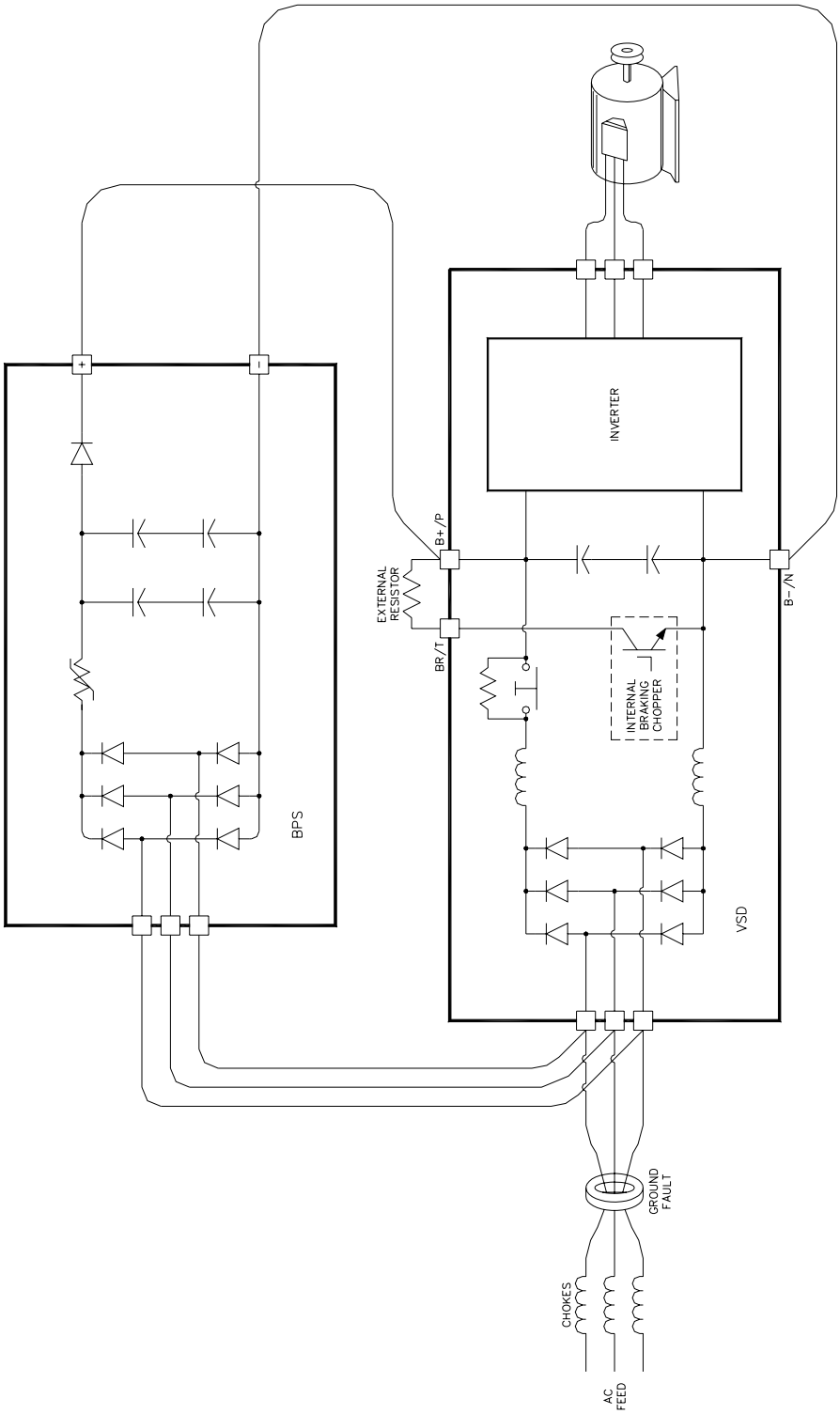


Figure 6-9: Outage Without Cap

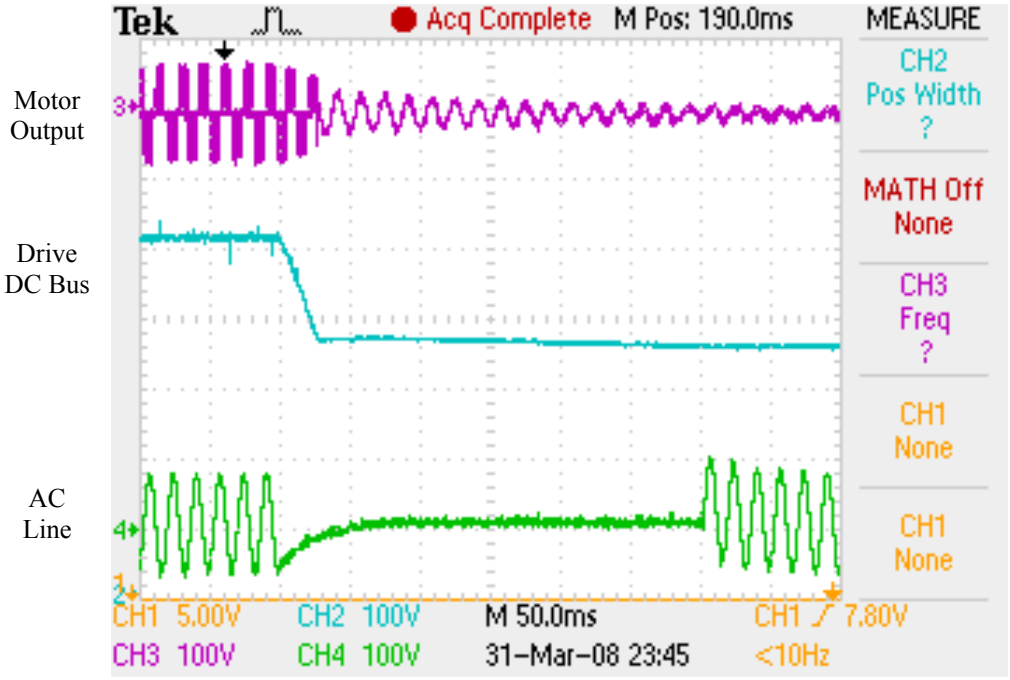
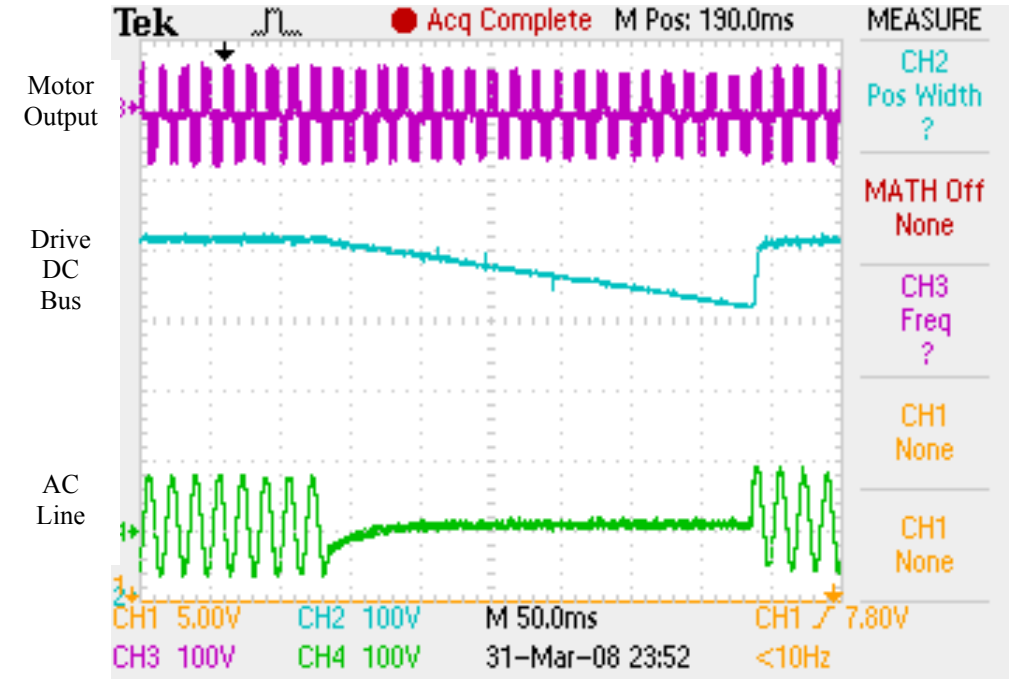


Figure 6-10: Outage With Add-on Electrolytic Cap



6.8. PARTS LIST

BONITRON PART #	DESCRIPTION	QTY
ASM 3534EC-E100-20-BR2A	2 x 700V/10,000uF Cap Assy w/tall bkt & no Booster	2
DI VU036-12N07	Diode bridge	1
FS A60Q5-2	DC Output fuse	2
FS ATM-10	AC Input fuse	3
FS HOLDR-05	3-Pole fuseholder 600V	1
FS HOLDR-10	2-Pole fuseholder 600V	1
IST METR25-750V	METER: 0-750 VDC (0-1 mA INPUT)	1
MTW 3534-BB-01	Flexible bus bar For ASM 3534EC Cap Bank Modules	2
MTW 3534-DISC	050010: V3: Bkt For ABB 6-pole disconnect	1
MTW 3534EC-TS	080124: G-Rail For M3534EC/CR term strip	1
MTW 3534-ROD	050012: Bracket to support disconnect rod	1
PLP 3534EC-02	040152: Lexan cover for (2) ASM 3534EC Cap Assemblies	1
RS 130W7800J	780 Ohm 130W w/ hdw	1
SW OA1G01	Aux contact	1
SW OHY65J5	Switch handle	1
SW OT25E6	6 Pole disconnect switch	1
SW OXP5X400	400mm shaft	1
TN PAD-AL-112-112	Thermstrate pad:	1
TS RW-AP2.5	Side cover/spacer	1
TS RW-EK2.5	27A ground terminal	1
TS RW-EWK1	End bracket	2
TS RW-SAK2.5	25A terminal	5
TS RW-TS32	Steel rail (6'6")	1
TS RW-TW2.5	030286: Partition for SAK2.5	1

6.9. RECOMMENDED SPARE PARTS

BONITRON PART #	DESCRIPTION	QTY
ASM 3534EC-E100-20-BR2A	2 x700V/10,000uF Cap Assy w/tall bkt	2
DI VU036-12N07	Diode bridge	1
FS A60Q5-2	DC Output fuse	1
FS ATM-10	AC Input fuse	1
RS 130W7800J	780 Ohm 130W w/ hdw	1
SW OA1G01	Aux contact	2
SW OT25E6	ABB #OT25E6: 6 pole disconnect switch	1

7. APPENDICES

7.1. APPLICATION NOTES

Bonitron manufactures several different BPS models for specific applications. The following is a general guideline for applying the appropriate model for best cost effectiveness. Short term outage is defined as less than 2 seconds, and long term outage is defined as more that 2 seconds.

1. Fractional to 3hp, 50% sag or 100% short term outage should consider M3534EC
2. Fractional to 3hp, 100% long term outage should consider M3534BR
3. 3hp to 67hp 50% sag should consider M3534RT
4. 3hp to 15hp 100% short term outage should consider M3534CR
5. 15hp to 67hp 100% short term outage should consider M3534UR
6. 3hp to 67hp 100% long term outage should consider M3534BR
7. 75hp to 2000hp 50% sag should consider M3460R
8. 75hp to 2000hp 100% short term outage should consider M3460UR
9. 75hp to 2000hp 100% long term outage should consider M3460B4

7.2. INSTALLATION CONSIDERATIONS

The following should be considered when installing a Bonitron Ride-Thru Module.

1. Inverter logic voltage must be "backed up"
   - Most new Inverters derive logic supply from DC bus
   - Install small UPS on circuits with AC feed
2. Any control or Interlock relays must be "backed up"
   - Test Relays at half voltage for dropout
   - Use DC relays on logic supply
   - Install small UPS on circuits with AC feed
3. Determine the maximum motor voltage needed
   - To ensure 455VDC level is sufficient to supply motor
     - Most inverters automatically compensate RMS to motor
4. Verify actual AC line voltage and DC bus level
   - To ensure Ride-Thru time from nominal level to 455VDC
5. Determine Inverter low bus trip point
   - To ensure 455VDC level is above inverter dropout
6. Electrical safety
   - Ride-Thru should not have AC power when inverter does not
     - RT and Inverted should feed from same point
     - Use shunt trip interlock between Inverter and Ride-Thru if RT power is not fed downstream of inverter power switch
     - Label inverter as having two power sources
7. IR drop of wiring
8. Maximum wire sizes allowed into Ride-Thru
   - Different models have standard max sizes
9. Local wiring codes
10. Ambient temperature
    - (under 50°C)
11. Environment
    - Determines cabinet type

7.3. USABLE ENERGY DATA FOR BSMS

This section provides data pertaining to the amount of available Usable Energy for DC bus voltage support provided by M3534EC Systems as well as the effect that drive system AC Line / Low Voltage trip levels have on these ratings.

The **USABLE ENERGY** available from a capacitive energy reservoir, such as the ASM 3534EC-E100 Bus Support Modules (BSMs) used in the M3534EC DC Bus Ride-Thru System, is the difference between the reservoir's total stored energy when charged to the normal DC bus level and its remaining energy when the DC bus drops to the low voltage trip setting of the drive system. Accordingly, the actual USABLE ENERGY of the reservoir can be optimized through higher AC line levels and/or lower drive low voltage trip settings.

In order to ensure that the M3534EC DC Bus Ride-Thru module will adequately provide sufficient energy during anticipated outages under typical field conditions, the USABLE ENERGY ratings listed in Table 6-1 were conservatively calculated based on a low AC line level (approx. 7% below nom. AC line) combined with a relatively high drive low voltage trip setpoint (15% below nom. DC bus).

Figure 6-1 depicts the relationship of AC line levels to usable energy for the ASM-3534EC-E100 Electrolytic Capacitive Bus Support Module when used in the M3534EC DC Bus Support system for 380VAC, 400VAC, and 415VAC drive systems. Figures 6-2, 6-3, and 6-4 show usable kilojoules at '~4% Low', '~7% Low', and '~10% Low' levels for each nominal AC line input level. All charts assume a 455VDC low bus level. While an inverter may continue to run at lower voltages, the output power is decreased to the motor.

Table 6-1 provides Usable Energy Ratings for M3534EC DC Bus Support systems utilizing up to 20 ASM-3534EC-E100 Bus Support Modules (BSMs). These ratings are based upon conservative estimates of drive system parameters.

7.4. CALCULATIONS

This section provides the calculations required to determine the optimum number of Bus Support Modules to be used when configuring a M3534EC DC Bus Support system.

There are three important calculations that must be made to properly size the system. First, the necessary capacity of the system to adequately support the drive system must be determined. Next, the actual Usable Energy level of the BSM type to be used in the system must be calculated based on drive system parameters. Finally, the first two calculations are used to determine the optimum number of BSMs to include in the system configuration. Each of these calculations is detailed below.

7.4.1. DETERMINING THE REQUIRED CAPACITY OF A M3534EC SYSTEM

The capacity or **USABLE ENERGY** rating (in kJ) of a M3534EC DC bus support system required to support a given drive system can be determined by multiplying the drive or load rating (in kW) by the duration (in seconds) of the outage to be protected against. Keep in mind that the M3534EC is rated for 2.2kW maximum. For load ratings greater than 2.2kW or 3kJ, the M3534CR may be added for a more cost effective solution.

The following formula is used to determine the required capacity (in kJ or hps) of a M3534EC System:

Capacity (kJ) = Load (kW) x Duration (seconds)
Capacity (hps) = Load (hp) x Duration (seconds)

To be sure that the M3534EC will always be sufficiently sized for the drive system, use the horsepower rating of the drive in the calculation. Since the load on the drive will not exceed the drive rating, the calculated capacity will always be sufficient. To determine capacity for a specific application where the drive may be oversized for the actual load, the horsepower rating of the actual load may be used.

7.4.2. CALCULATING THE ACTUAL USABLE ENERGY OF ONE ASM-3534EC BSM

In order to provide a reliable general guideline for properly sizing a model M3534EC DC Bus Support system, the **USABLE ENERGY** ratings for ASM-3534EC-E100 BSMs, as listed in the Table 6-1, were calculated based on the combined conservative assumptions of a low AC line input level and relatively high drive Low Voltage trip setpoint. This helps to ensure that the M3534EC system will adequately perform under actual field conditions.

However, to more accurately determine the actual **USABLE ENERGY** of an ASM-3534EC Bus Support Module when used for support of a drive, 3 specific values must be known:

1. the capacitance of the BSM (10,000uF for the ASM-3534EC-E100)
2. the normal operating DC bus voltage for the drive system
3. the low voltage trip setpoint of the drive

The following equation is used to calculate Usable Energy (in *joules*) of a capacitive energy reservoir:

$$E_U = E_S - E_R$$

Where

E_U is the actual Usable energy (in *joules*) available from the capacitive reservoir to provide DC bus support during outage or dip situations.

E_S is the total Stored energy (in *joules*) in the capacitive reservoir during normal operating conditions.

E_R is the total unused Remaining energy (in *joules*) in the capacitive reservoir after the drive unit has tripped due to low voltage conditions.

Before the Usable Energy (**E_U**) can be calculated, it is necessary to first calculate the Stored Energy (**E_S**) and Remaining Energy (**E_R**) values.

The following equation is used to calculate both Stored and Remaining Energy (in *joules*) for the capacitive energy reservoir:

$$E = \tfrac{1}{2}CV^2$$

Where

E is energy (in *joules*)

C is the total capacitance (in *farads*) of the ASM-3534EC BSM

V is DC voltage. For **E_S** calculations, this is the DC bus voltage during normal operating conditions. For **E_R** calculations, this is the drive's 'Low Voltage' trip setpoint.

Once the Stored and Remaining energy calculations have been completed,

simply plug the values into the Usable energy equation and convert the results to horsepower-seconds, using the conversion factor below, to arrive at the Usable Energy rating.

If **joules = watt-seconds**

and **watts x 0.001341 = horsepower**

then **joules x 0.001341 = horsepower-seconds**

7.4.3. DETERMINING THE REQUIRED NUMBER OF BSMS FOR THE M3534EC

Now that a value for 'Usable Energy' has been determined for a single BSM, divide this number into the previously calculated 'Required Capacity' value to determine the required number of BSMs to be included in the M3534EC system.

Req'd Capacity(hps) ÷ BSM Usable Energy(hps) = BSM Qty

7.5. DETERMINING ACTUAL CAPACITY FOR AN EXISTING SYSTEM

To quickly prove the remaining capacitance in any 3534EC BPS system, the following method can be used.

12. Determine discharge curve using oscilloscope or voltmeter and stopwatch
    a. Note voltage at beginning of discharge
    b. Calculate 36.8% of beginning voltage
    c. Remove power and apply known resistive load, noting the time it takes to drop to 36.8% of original voltage
13. Calculate capacitance by dividing the time it took to get to 36.8% of beginning voltage, by the discharge resistance

Example: Beginning voltage is 535VDC. Discharge resistance is 780 ohms.

36.8% of 535 can be found by multiplying 535 x .368. This equals 196VDC.

Note that it takes about 16 seconds to drop from 535 to 196V. Now divide 16 seconds by 780 ohms to get .02051. This answer is in Farads, so next multiply by 1 million to get nameplate rating in uF. .02051 x 1,000,000 = 20,510uF.

NOTES